Towards a Wave Theory Interpretation of Time-Distance Helioseismology Data

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Time-distance helioseismology, which measures the time for acoustic waves to travel between points on the solar surface, has been used to study small-scale three-dimensional features in the sun, for example active regions, as well as large-scale features, for example meridional flow, that are not accessible by standard global helioseismology. The interpretation of travel times has typically been done in the ray approximation. The interaction of acoustic waves with features smaller than their wavelength, for example in active regions or in the tachocline, is not expected to be well represented by ray theory.

In order to develop a wave interpretation of time-distance data we employ the first Born approximation, which takes into account finite-wavelength effects and allows a single scattering between the source and receiver of the acoustic wave. We show the sensitivity of travel times to flows and structure perturbations and compare the results with ray theory.

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